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DISCUSSION OF
NATIONAL TOPOGRAPHIC MAPPING
(*Published in April, 1951*)

By Milton O. Schmidt, D. P. Krynine,
and W. E. Wrather

SURVEYING AND MAPPING DIVISION

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DISCUSSION

MILTON O. SCHMIDT,⁵ Assoc. M. ASCE.—The brevity of this paper is in marked disparity with the importance of its subject in a time of armament for world-wide struggles and the use of military strategies geared to the availability of reliable maps and charts. Although maps play a vital role in the conservation of natural resources and are indispensable in modern warfare, the national mapping program still limps. The author might have scored the Congresses following the passage of the lamentable Temple Act for not making it a workable piece of legislation. Other abortive ventures such as the Hayden-Ickes Bill of 1937 followed in the same tradition.

It would be difficult for many engineers to understand why the plan proposed in 1951, calling for the completion of the topographic atlas of the United States in a 20-yr period at an annual cost of \$25,000,000, may also prove a fiasco. Such a calamity can be prevented by telling the story of map needs to Congress in vivid language that the lawmakers can understand. Congress must be convinced that the implementation of a surveying and mapping program (that will cost no more than one aircraft carrier a year) may bring to the military establishment data vitally needed for the defense of the Great Lakes Region and other areas of the United States. Such implementation would also provide a topographic map base of incalculable value for the peacetime planning needs of city, state, and the nation.

Engineers have long berated the legislative bodies for their indifference toward supporting national mapping programs. Furthermore, the apathy of the general public has added to the disinterest of the solons. The engineering profession must strive as earnestly for legislative championing of mapping as the medical profession attacked plans for socialized medicine. The mysteries of topographic symbolization of the typical map must be translated so that a map is seen as a document of great worth. It can become a tool of vast utility and make possible more efficient planning and use of the nation's resources.

One element of a sound mapping program must be an assurance that financial support will continue. Otherwise, normal obsolescence will make the sporadic mapping program useless. Furthermore, the program should be entirely federal because the disinterest of some strategically situated state might cause that unmapped area to become the nation's Achilles' heel. A measure that affects the safety of the entire nation cannot brook the indifference of a single area and for lack of state funds hazard the security of the United States.

Under a program of the scope outlined by the author, it can be confidently expected that improvements in techniques and equipment that are expected concomitants of increased mapping activity will effect a lowering of unit costs in all cartographic operations. The magnitude of the undertaking and the pride of accomplishment engendered in the personnel cannot help but hasten more rapid and cheaper mapping processes.

⁵ Associate Prof. of Civ. Eng., Univ. of Illinois, Urbana, Ill.

Maps are invaluable to the federal agencies and through them to 150,000,000 Americans and their allies to the north and south. Toleration of cartographic programs falling below the level of a 20-yr project is economically indefensible and morally derelict in case of war on American soil. The task of convincing Congress and the state legislatures of the need for accelerated mapping devolves on the people who use maps and recognize their great potentialities. The problem has yet to be an engineering colossus. It is one for the civilian engineering groups and the military to persuade Congress logically and relentlessly to extend modest but continued financial help to an enterprise vital to the nation in peace and war.

D. P. KRYNINE,⁶ M. ASCE.—An interesting and exceedingly important matter has been brought to the attention of the engineering profession by the author of this paper. At a time when life expectancy has risen considerably there are quite a few living and still active engineers approximately of the same age as the United States Geological Survey (USGS) who saw the adventure of the development of topographic mapping by the USGS in the United States, the continuous progress in the preparation of maps, and their increasing usefulness in the engineering projects (especially those that spread across an area, such as irrigation projects, or extend along a distance, such as highways or canals). The railroad location era is practically over in the United States, but the old railroad men should remember with gratitude the help received from the USGS maps in their days.

The writer wishes to emphasize the necessity of providing all topographic maps with grid systems. Engineers need maps on larger scales, referred to orthogonal axes of coordinates for convenience in measurements. A grid consists of two sets of parallel lines intersecting at right angles to form a network consisting of squares. This grid is applied to plane areas that, for mapping purposes, replace actual areas at the earth's surface. This replacement, though made according to certain rules, involves some distortion that may be considered negligible so far as the length of the lines and the angles made by them are concerned. The side of a square of the grid may be as large as 3000 yd or as small as 1000 ft. The x -coordinates increase in the west-east direction, and the y -coordinate in the south-north direction (mnemonic rule "read right up").⁷

There are several systems of grids. The United States military grid system subdivides the continental United States into seven zones labeled from A to G in the east-west direction. Thus, the State of Connecticut is located within the A-zone whereas California is located mostly within the G-zone. The world grid, as the writer understands, is practically an extension of the United States and British military grid systems. The state coordinate systems^{8,9} are based on the fact that in a strip of the earth 158 statute miles wide (counting along a meridian) the difference in length between the actual or geodetic length of a

⁶ Cons. Engr., San Francisco, Calif.

⁷ "Military Maps and Air Photographs: Their Use and Interpretation," by Armin K. Lobeck and Wentworth J. Tellington, McGraw-Hill Book Co., Inc., New York, N. Y., 1944.

⁸ "The State Coordinate Systems," by H. C. Mitchell and L. G. Simmons, *Special Publication No. 235*, U. S. Coast and Geodetic Survey, Govt. Printing Office, Washington, D. C., 1945.

⁹ "Use of State Plane Coordinates in Route Surveying," by H. C. Mitchell, U. S. Coast and Geodetic Survey, Washington, D. C., 1950 (lith.).

line and its length on the grid constructed for that strip is negligible (less than 0.01%). The territories of the states are thus subdivided into grid areas not exceeding 158 statute miles in the south-north direction. In this connection, California has seven grid areas and Connecticut only one. The state grids are being introduced in various states by legislative enactment.

Besides the USGS, the United States Coast and Geodetic Survey (USCGS) is active in the preparation of the topographic maps. It establishes the primary vertical and horizontal control nets which, afterward, are subdivided into third-order and fourth-order control nets by the USGS. Topographic maps based on the United States military grids are prepared by the Corps of Engineers, United States Army. On these maps (which generally are carefully prepared) highways and roads are well drawn, and their condition is recorded.

Engineers interested in shore and harbor structures have to consult "charts" prepared by the USCGS.¹⁰ These charts cover the Atlantic, Gulf, and Pacific Coasts, and also Alaska, Puerto Rico, Hawaii, and the Philippine Islands. These charts are conveniently drawn on decimal scales.

Air photos are very useful in engineering practice, as the author of the paper also states, and in many occasions they are preferable to topographic maps. In general, however, air photos are not, and will not be, competing with topographic maps; they simply complement them. An analogy in the field of transportation is the role of railroads that are still very useful in the country's economics, but are complemented by the highway and aircraft traffic.

The writer is far from being a specialist in mapping, but he is a user of maps to a considerable extent, and this discussion should be considered as an expression of the opinion of a rank-and-file engineer who greatly appreciates the work of the USGS along these and other lines.

W. E. WRATHER¹¹.—The writer is naturally in full agreement with Mr. Krynine in believing that national topographic mapping is important to the efficient use of natural resources and to the logical planning of engineering projects.

Mapping of large areas on the surface of the earth is referred most conveniently to the basic geographic system in terms of latitude and longitude; so, from the beginning of organized mapping efforts many years ago, the topographic quadrangle maps that are units of the national mapping system have been framed within evenly spaced meridians and parallels. This is a good arrangement for the map maker.

Although the same geographic reference system is also satisfactory to many map users, engineers very frequently prefer rectangular coordinates for local surveying projects. To meet such requirements the two systems mentioned by Mr. Krynine were developed by the USCGS. The "Grid System for Progressive Maps in the United States," in yards, was primarily for military use. It has been superseded by the "Universal Transverse Mercator" (UTM) grid, in meters, which was adopted in 1947. The "State Coordinate Systems,"

¹⁰ Catalog of Nautical Charts and Related Publications, U. S. Coast and Geodetic Survey, *Serial No. 665* (Nautical Charts, Tidal Current Charts, Coast Pilots, Tide Tables, Current Tables), October, 1949.

¹¹Director, U. S. Geological Survey, Washington, D. C.

in feet, were designed for the convenience of local surveyors, project engineers, and other civilian users; they are based either upon the Lambert conformal projection for long E-W zones, or upon the transverse Mercator projection for long N-S zones.

Mr. Krynine is in agreement with many other important map users in believing that the topographic maps should show the rectangular coordinate systems. These provide the information required to correlate local engineering surveys, using rectangular coordinates, with the details on the maps. The method used to show the grids is to print small "ticks" in the margins of the maps, so that anyone who so desires may draw the grid lines across the map he is using. The "ticks" for the state coordinate systems appear on the civil editions of practically all new quadrangle maps published by the USGS since 1942, and on reprints of many older maps. The military grid, in yards, was generally indicated on maps published from 1925 to 1941. The new military grid, in meters, is now indicated only on military editions, and "ticks" for the state grids, in feet, are shown only on the maps for civilian use.

Mr. Schmidt is quite right in his statement that a national mapping program cannot be executed properly and economically without a stable long-range plan for financing such work. The Temple Act was workable legislation, but the mapping program it authorized failed to become a reality because the funds to support it were not appropriated.

In fairness to the government agencies charged with the responsibility of proposing and defining the mapping program, and the Congress which must consider the proposals and appropriate the funds, it should be stated that since World War II significant progress has been made. Funds have increased each year and the USGS is now staffed and equipped to a point where a noticeable advance is made each year toward getting the mapping job done. The present rate of progress, although not sufficient to finish this work before 1970, is within striking distance of that goal.

The existing national emergency has had the effect of stimulating the program in some respects, but it has also retarded progress somewhat because of the necessity of utilizing considerable capacity in the preparation of maps and charts covering foreign areas. At the present time, the military continues to support strongly an expanded mapping program and, if the engineering groups throughout the United States would consolidate their interests into an equally specific indication of their needs, a mapping program of the scope and magnitude needed to provide adequate topographic map coverage for the United States and its territories would soon be launched.

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